ISSN: 0974-5823 Vol. 6 No. 3 (October-December, 2021

International Journal of Mechanical Engineering

Application Software Integration Testing and Functional Testing

Dr. D. Janaki Sathiya

Assistant Professor (Sr.G)Department of EEE, PSG College of Technology, Tamilnadu, India.

Abstract:

Testing the automobile is an important part in the automobile industry, where each components of the car must be tested. Both simulation and on road test are used, however simulation tests cover a huge variety of scenarios to test and even reduces the effort and time. This paper describes a simple automobile simulation model which can be developed to test the speed and other interface signals in the car by the help of MATLAB. Also the overview of creating the automated verification module for the integration and the functional testing is presented with SIMULINK.

I.INTRODUCTION

The automobile industry covers a wide variety of works like design, development, manufacture, testing, maintenance and marketing of the cars, trucks, trains etc. Each phase has a planned working strategy. However at times there are situations where the unplanned scenario occurs. They occur either due to the untrained usage or due to some error between the communication from one component to the other. Analysing the cause for the defect after the damage and then rectifying it is an inefficient work process. This in turn bring down the growth of the product and the service as it puts the customers resource in danger. Therefore proper testing of the resources under all the situations must be done to overcome the unexpected. However the testing on real time require lots of additional resources and developments. Dangerous situations or failure modes are possible to test which occur rarely in real worldby means of simulation. This testing is done in simulation which reduces the time and man power required in testing by covering large scenario at a quick time and even effectively. A simple effective means of testing with the simulation environment can be developed by the Math Laboratory (MATLAB) software. This requires to design a model of the all the basic and the advanced safety components in a simulation environment. The basic model of theelectric car can be used for simulation where the state of charge of the battery, the velocity of the automobile body, the distance covered and other overall features can be modelled. However for the testing all the components starting from the light control to the safety protection such as adaptive cruise control module must be simulated. For which the Electronic control unit is to be considered which is responsible for a specific function like oversteering, regulation and altering the operation of the car. Based on the function the control unit is grouped under different types like engine control module, suspension control module, steering control module, transmission control module etc. The testing of each of the ecu unit is necessary as each plays an important role in the complete functioning of the car. ECU also communicates with the other ECU, there must be proper compatibility between the datatype and the signals so that the communication is uninterrupted. Therefore both integration testing and functional are essential for the validation of the model.

This paper outlines the testing methods by means of simulation where the different driving scenario can be generated. Section II describes the earlier related studies which are conducted in testing via simulation. The overview of testing is described in section III. Section IV describes the simulation of the basic automobile model and the electronic control model via simulation along with the development of the rules to automate the scenario. The analysis of the output signals generated and the testing is described in section V.

II.LITERATURE REVIEW

The complexity of autonomous driving system are increasingly rapidly with the new development to provide the safety and the comfort. There are many testing methods for its evaluation. ADAS and the automated driving systems commonly use the virtual or real testing methods where the model is developed in laboratory. The testing which are commonly available are the virtual simulation testing, from simulated sensors, vehicle dynamic model and controller, virtual driver, to simulated comprehensive traffic environment. The function of various components are tested by software in the loop or hardware in the loop (HIL) or vehicles in the loop (VEHIL) or mixed simulation methods [1,2]. FOT kilo meters testing [3] are used for autonomous driving systems. The dedicated software for simulation contains mathematical representation of thesubsystems which are used to achieve realistic system [4-6]. The testing practices used, requires automatically created test cases, hardware-in-the-loop (HIL) testing, change- based testing and the mapping of tests cases to requirements [7]. Hardware-in-the-loop (HIL) testing is provided for sensor, communication systems, and function modules. The real code can then be verified with Software-in-the-loop (SIL) simulations, where the remaining hardware components, vehicle dynamics, and environment are simulated in real-time [8]. Vehicle-in-the-loop (VEHIL) simulations provide a solution for testing a full-scale autonomous vehicle in a HIL environment [9-10].

III TESTING

Software testing involves testing the functionality of a software application to find if the developed software meets the specified requirements or not. It is also used to ensure if the software is defect free to produce the good quality product. It checks if the application is bug free, if it meets the technical requirements, if it meets the user requirements with handling all the exceptions and boundary cases. It also stands as a measure to improve the software interms of efficiency, accuracy by evaluating its specification, functionality and performance. Based on how the test is created and how it is being executed, they are classified into manual testing and automatic testing. Manual testing the testers uses the software by hand to test the application. The initial inputs required are given manually by the tester and the outputs are verified by the testers with the perspective of the end users.

Automation tools enable testing where software is used to find the defects. Based on the necessity of the test and the part or logic which is being tested, the testing can be of many types. The most commonly followed testing for any software are integration testing and the functional testing. The most common and important types of software testing is the integration testing where the individual units or components are tested to test the connectivity among all the units. The formal type of testing are the functional testing which is performed by testers which focuses on testing the software against the functionality for which it is developed.

IV. AUTOMOBILE SIMULATION

The automobile simulation requires to model the components, which is done by the predefined SIMLUINK blocks available in the MATLAB environment. The main components for any basic automobile are the vehicle body, the control unit, the motor and the batterywhich are developed in simulation. Fig 1 shows the developed basic model for an electric car.

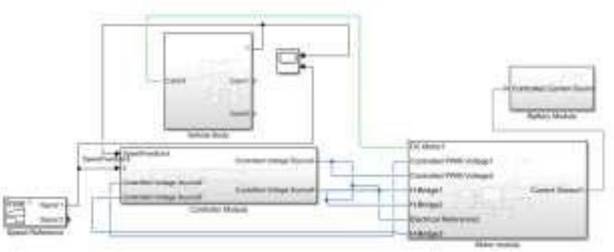

Fig 1: SIMULINK model for an automobile The vehicle body consist of the four

wheel, where each one is a simple, no-slip model of a tire parameterised by its radius whose inertia and the damping can be included. It also include a body which represents a two-axle vehicle body in longitudinal motion. This accounts for the body mass, aerodynamic drag, road incline and weight distribution between axles sue to acceleration and road profile. Pitch, suspension dynamics and additional variable mass and inertia can be specified if needed. Fig 2 shows the vehicle body subsystem

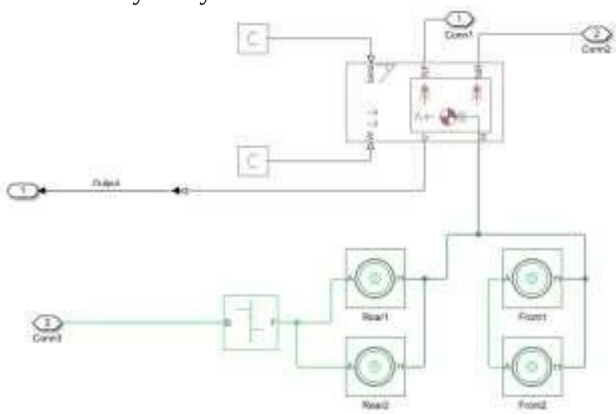

Fig 2: Simulation model for vehicle body The lectrical and torque characteristics

of a DC motor are represented by the motor block. The block assumes that noelectromagnetic energy is lost, and hence the back-emf and torque constants have the same numerical value when in SI units. Motor parameters can either be specified directly or derived from no-load speed and stall torque. H-bridge block represents a motor drive. The Current Sensor block represents another sensor, specifically it measures the current drawn by the motor. The ground for the electrical portion of our system is defined by the Electrical Reference block. The block is driven by the Controlled PWM Voltage block in PWM mode or the Averaged mode. If the REV port voltage is greater than the Reverse threshold voltage, then the output voltage polarity is reversed. The switching frequency of Controlled PWM Voltage block is given as 4000Hz. Fig 3 shows the motor module subsystem.

The controller splits the input signal for both the acceleration and the deceleration (brake). The battery model shows a high- voltage battery circuit that can be used to power an Electric vehicle. The battery is configured with a nominal voltage value of 100v and 50A current is shown in fig 4.

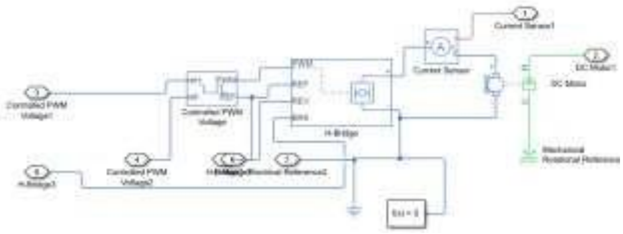

Fig 3: Motor submodule

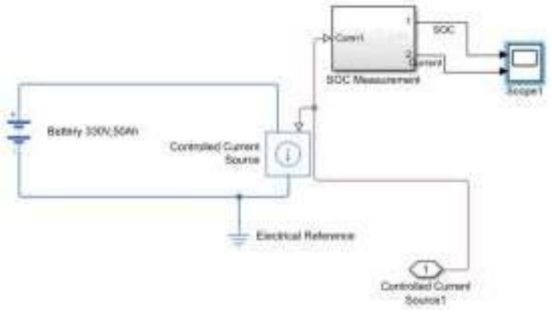

Fig 4: Battery sub module

The basic model is used for the overall verification of the functionality of the automobile, for further validation the control units are developed. The steering control unit which mainly controls the rotation of the wheel in accordance to the angle rotated by the steering wheel. The functionality of the steering control unit is monitored by the yaw rate of the wheel. The revolutions of the steering wheel is counted by the steering wheel sensor, its speedis compared to those set of standards which arethen given to the control unit. If a change deviating from the standard value is detected then the control unit will send signals to make necessary adjustments and corrections to stabilize the vehicle.

The rotation rate of the car body is measured by the yaw rate sensor. It determines how far off-axis a car is tilting in a turn and sends it to a microcomputer that compares the data with wheel speed, steering angle and accelerator position, if the system senses too much yaw, the appropriate braking force is applied. After the development of the steering module the yaw rate is found by the simulation which determines the functionality of the steering module. The steering module also sends signals to other control units like the ECU which transfer the signal to the led which servesas the indicators for the other vehicle. The functions which depends on the rotation of thesteering wheel is shown in fig 5.

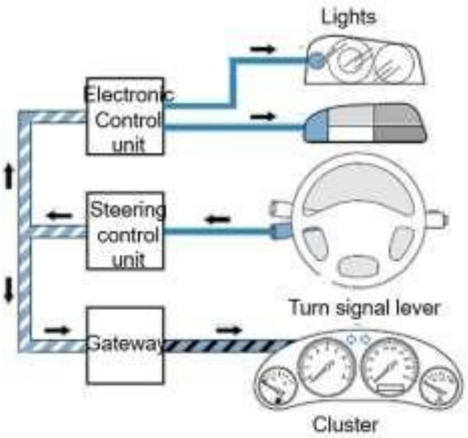

Fig 5: Steering interface

The cluster is a network of many indicators which are available in the dashboard of the car. The integration testing validates the proper transmission from one control unit to the other.

V. TESTING MODULE

The testing should cover all thescenario, it must cover the worst case that can ever happen. First the test specifications considering all the functions to be tested is developed along with the verification criteria listed for the evaluation for example the yaw rate signal is to be tested to find if the body of

the vehicle is turned in accordance with the steering wheel.

The next step involves the simulation environment for the testing which involves the wind, the slope, the friction coefficient. Based on the test case scenario the input to the vehicle is set. The simulated signal for steering angle is shown in fig 6. The signal is the one corresponding to the changes in the steering angle which shows that the steering wheel witha small turn in both direction. The steering module is checked if the steer wheel turn turnsthe vehicle body, which is found by the yaw rate of the vehicle. The yaw rate of the body is calculated by the yaw rate sensor and is shown in fig 7.

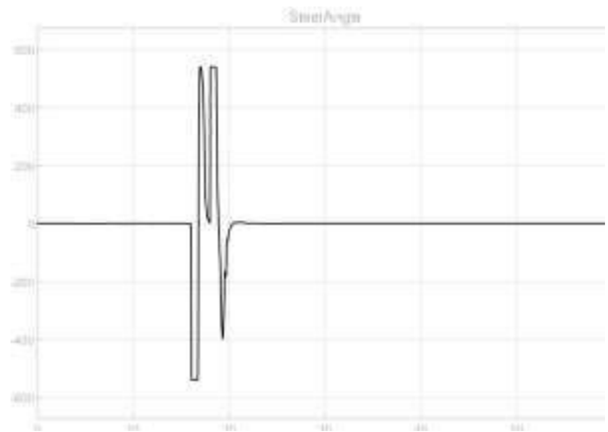

Fig 6: Steering angle sensor output signal

From the observation of the signals the steering wheel turn correspondingly turns the body of the vehicle thereby indicating that the basic functionality of the steering module is performed correctly. Similar all the signals are obtained and are analysed based on the model requirement. For the verification a Simulink model which checks the signal is constructs as shown in fig 8.

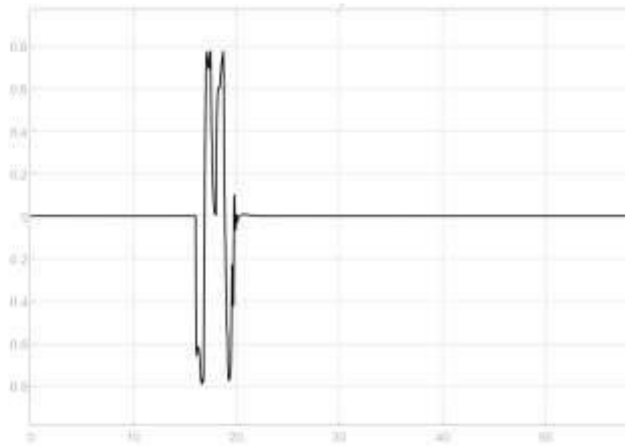

Fig 7: Yaw rate sensor output signal

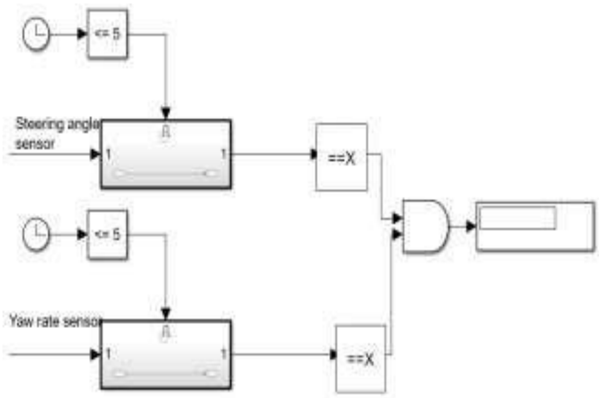

Fig 8: Verification module

In this model the signal which is the steering angle sensor input, checks if the angle of steering at time 5 seconds after the initiation of the vehicle. The yaw rate sensor signal is also checked to verify if the vehicle body turns at the same time as that of the steering angle. If the simulated vehicle model gets passed the verification Simulink model then the given test case is verified. Once the verification model corresponding to the given input is developed it is used n times for checking the conditions with different input speed or different updated car model.

Conclusion

The simulation model of the car and the verification module once created it fastens and reduces the man power for manual testing, checking all the possible conditions of the automobile thereby enhancing the testing mechanism. The simulation model can be extended to include all the safety and security components along with all the miscellaneous circuits. The automated test suit is to be created which include all the possible test criteria to meet the unexpected event. With the test suit the complete testing of all the function can be done.

REFERENCE

[1] C. Guhmann, J. Riese, and K. von Ruden, “Simulation and Testing for Vehicle Technology.”

[2] R. Schilling, and T. Schultz, "Validation of Automated Driving Functions," Simulation and Testing for Vehicle Technology, pp. 377-381: Springer, 2016.

[3] M. Hjort, H. Andersson, J. Jansson, S. Mårdh, and J. Sundström, “A test method for evaluating safety

[4] M. R. Heinen, F. S. Osório, F. J. Heinen, and C. Kelber, “SEVA3D: Autonomous Vehicles Parking Simulator in a three-dimensional environment,” INFOCOMP Journal of Computer Science, vol. 6, no. 2, pp. 63-70, 2007.

[5] M. Kuderer, S. Gulati, and W. Burgard, "Learning driving styles for autonomous vehicles from demonstration." pp. 2641-2646.

[6] R. Austin, Unmanned aircraft systems: UAVs design, development and deployment: John Wiley & Sons, 2011.

[7] M. Broy, "Challenges in automotive software engineering." pp. 33-42.

[8] M. Buhren, and B. Yang, “Simulation of automotive radar target lists using a novel approach of object representation,” in 2006 IEEE Intelligent Vehicles Symposium, 2006, pp. 314-319.

[9] A. Sidhu, “Development of an Autonomous Test Driver and Strategies for Vehicle Dynamics Testing and Lateral Motion Control,” The Ohio State University, 2010.

[10] C. Miquet, "New test method for reproducible real-time tests of ADAS ECUs:“Vehicle-in-the-Loop” connects real-world vehicles with the virtual world." pp. 575-589.